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Technical Support Document

Mobile Source Emissions Modeling for the 1995 California FIP

EPA Office of Mobile Sources

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Introduction

This document is intended to supplement and support the 1995 Federal Implementation Plan for California. The tables "Mobile Source FIP Inventories and Benefits" at the end of this document summarize the attainment year inventories by source category for both highway and nonroad sources.

Following are detailed explanations of the calculations used to estimate the base year and attainment year highway and nonroad mobile source emission inventories. Additional information for certain sources and control measures may be found in separate documents (e.g., the ILEV program and locomotives and aircraft-related sources). For detailed descriptions of the control programs mentioned here the reader should refer to the FIP preamble.

1.0 Highway Inventories and Benefits

For the most part the highway inventories and control measure benefits for the FIP were determined with CARB's EMFAC7F/BURDEN7F models for consistency with SIP and conformity inventories. Thus, the vehicle miles traveled (VMT) assumptions were those incorporated in BURDEN7F rather than the more recent VMT estimates used in the FIP proposal or even more updated estimates that are expected to be incorporated into BURDEN7G.

The main reason EPA had not used EMFAC for the FIP proposal was the inability of EMFAC to model some of the control measures that had been considered for the FIP. Since that time, CARB agreed to make the necessary modifications to EMFAC to allow modeling of certain FIP control measures, such as the stringent FIP enhanced inspection/maintenance program.

1.1 Baseline Inventories

The 1990 highway inventories were taken directly from EMFAC7F/BURDEN7F outputs provided by CARB for each of the three nonattainment areas.

The attainment year baseline inventories were provided by CARB and were the same inventories used for the SIP adopted November 15, 1994. These baseline values include the effects of California's current test and repair 2-speed idle I/M test program, the LEV program, reformulated gasoline, and California's clean diesel fuel. Also included are adjustments to the straight EMFAC/BURDEN inventories to account for the existence of the national 4.0 g/bhp-hr NOx standard for heavy duty vehicles beginning in 1998.

1.2 Benefits of Control Measures

1.2.1 Enhanced Inspection & Maintenance (FIP tight cutpoint I/M program)

In the interest of consistency with the SIP and conformity inventories, CARB offered to provide EPA with EMFAC-based estimates of the benefits of FIP measures, such as the FIP I/M program. To accomplish this, EPA provided CARB with detailed estimates of the exhaust and evaporative emission control factors associated with the FIP I/M program for each model year and each vehicle type that would be subject to I/M. These control factors were based on EPA's CALI5 model, since it was the most up-to-date model available at the time (September 1994) that was capable of modeling the FIP enhanced I/M program in California. CARB was then able to use EMFAC by-model-year outputs for a no-I/M case and apply the appropriate control factors to simulate the FIP I/M program in each of the three areas.

As described in more detail in the FIP preamble, the FIP I/M program calls for IM240 testing of 1966 and later model year gasoline fueled vehicles, except for motorcycles. CALI5 modeling of this program was done by specifying the model year 1981 and later test type as IM240, and the pre-81 model year test stringency was set to 40%. Although actual testing of 1966-1980 vehicles would be done by IM240, the benefits expected for these vehicles are the same as if tested with the Basic I/M idle test that is assumed in the CALI5 (and MOBILE5) models for any pre-81 vehicle I/M testing.

The FIP also includes provisions for purge/pressure testing of 1971 and newer vehicles. The CALI5 input files called for 1966 and later purge/pressure testing, but since CALI5 only goes back 25 model years and the earliest evaluation dates modeled were 2005 for VOC and NOx and 2000 for CO, any beginning model year prior to 1975 yields identical modeling results.

1.2.2 49-State Importation Restriction Benefits

Vehicles certified to 49-State standards were assumed to comprise approximately 10% of the light duty VMT and 22% of the heavy duty VMT in the FIP areas, in accordance with EMFAC assumptions. The benefits of restricting importation of the light duty vehicles as described in the preamble were calculated using draft versions of the EPA MOBILE5b and CALI5b models, since CARB was not attempting to provide EMFAC-based modeling of this measure.

More specifically, the benefits were calculated for light duty vehicles and light duty trucks using 49-state vehicle emissions from MOBILE5b and California-certified vehicle emissions from CALI5b along with the 10% 49-state vehicle VMT weighting and the assumption that 80 percent of the 1999 and later model year 49-state vehicle VMT would change to California vehicle VMT. The remaining 20 percent of 49-state VMT was estimated to represent 49-state vehicles driven into California by visitors and vacationers.

1.2.3 Medium and Heavy Duty New Vehicle Standards

Since the SIP and FIP emission standards for medium and heavy duty vehicles are comparable, the inventories and control measure benefits for these vehicles were taken directly from the SIP.

1.2.4 ILEV Fleet Program

The ILEV program is expected to reduce VOC emissions by eliminating the evaporative emissions from vehicles meeting this standard. It was estimated that 8 percent of the VMT in each FIP area would be attributable to ILEV's. Full details of these calculations can be found in the FIP Regulatory Impact Analysis.

2.0 Nonroad Inventories and Benefits

A wide range of nonroad engines and vehicles are covered in this document, from small hand-held gasoline lawn and garden equipment to heavy duty diesel engines used in farm and construction work. Aircraft are covered briefly here with the remaining explanation in a separate document. Locomotives are covered totally in a separate document.

2.1 Baseline Inventories

The 1990 nonroad inventories were taken directly from detailed inventories provided by CARB in August 1994 for each of the three nonattainment areas.

The FIP baseline attainment year inventories for all of the nonroad categories were taken directly from CARB estimates. These baseline values include the effects of California's phase 2 reformulated gasoline, clean diesel fuel, and the national 6.9 g/bhp-hr NOx standard for preempted nonroad heavy duty engines.

In most cases the CARB inventories used were those from the November 1994 SIP, but for small gasoline utility engines (lawn & garden) more detailed CARB inventories obtained by EPA in August 1994 were used, because they contained the growth factors and control factors that CARB used to project the attainment year inventories. An inventory that used only the growth factors but not the control factors was necessary to allow use of control factors based on EPA guidance rather than the control factors that had been used by CARB.

Growth factors for small gasoline engines by county were provided to EPA by CARB in August 1994 and updated in January 1995. There were different growth factors for commercial use versus residential use, so these were weighted together according to the 1990 VOC emissions from commercial versus residential use. For South Coast and Sacramento these county specific factors were then weighted together according to the 1990 VOC emissions for each county in the nonattainment area to obtain an overall small engine emission growth factor for each area. The resulting growth factors are as follows.

South Coast	2010	1.811
Ventura	2005	1.258
Sacramento	2005	1.508

2.2 Benefits of Control Measures

2.2.1 Heavy Duty Nonroad Engines Greater Than 50 HP

The FIP baseline inventory for heavy duty nonroad engines assumed the existence of the California and federal 6.9 and 5.8 g/bhp-hr NOx standards that are phased in starting in 1996. This baseline was taken directly from the final 1994 SIP. Since the SIP did not include a 4.0 g/bhp-hr NOx standard for heavy duty nonroad engines, the percentage reduction benefits of this FIP measure relative to the 6.9/5.8 g/bhp-hr standards were calculated using a spreadsheet model based on the engine categories and usage assumptions from the 1991 EPA Nonroad Engine and Vehicle Emission Study (NEVES). Following are the resulting control factors, which are expressed as a ratio of the nonroad heavy duty NOx inventory with the FIP 4.0 gram standard to the inventory with the baseline 6.9/5.8 standards.

South Coast	2010	0.817
Ventura	2005	0.941
Sacramento	2005	0.939

2.2.2 Spark Ignition Engines Less Than 25 HP (Lawn & Garden)

CARB baseline inventory values were used for both residential and commercial lawn and garden engines. Benefits for federal phase 1 and phase 2 control measures were calculated by EPA using benefits described in the EPA guidance memo, "Future Nonroad Emission Reduction Credits for Court-Ordered Standards," (November 28, 1994). The Phase 2 control stringency was assumed to be a 90% HC reduction from uncontrolled levels for new engines with a phase-in beginning in 1996. Following are the control factors, which are expressed as a ratio of the small gasoline engine inventory with the FIP standards to the inventory with the baseline uncontrolled emissions.

		HC	NOx
South Coast	2010	0.100	1.986
Ventura	2005	0.408	1.979
Sacramento	2005	0.408	1.979

2.2.3 Recreational Marine Engines

The baseline recreational marine inventory was based on November 1994 SIP data for gasoline engine boats and detailed diesel boat inventory data provided by CARB in August 1994.

Benefits for federal recreational marine control measures were calculated by EPA using guidance contained in the EPA memo, "Future Nonroad Emission Reduction Credits for Court-Ordered Standards," (November 28, 1994). The ratio of outboard engines to inboard/sterndrive was taken from the 1991 EPA Nonroad Engine and Vehicle Emission Study (NEVES). Following are the control factors, which are expressed as a ratio of the indicated marine inventory with the FIP standards to the corresponding inventory with the baseline uncontrolled emissions. The marine diesel NOx control factors are less stringent than the nonroad heavy duty diesel equipment control factors in the guidance memo because the implementation date is later for engines under 750 hp.

			HC	NOx
South Coast	2010	Outboard	0.676	2.138
		Inboard/Sterndrive	1.062	0.967
		Diesel	1.000	0.840
Ventura	2005	Outboard	0.868	1.462
		Inboard/Sterndrive	1.025	0.986
		Diesel	1.000	0.935
Sacramento	2005	Outboard	0.868	1.462
		Inboard/Sterndrive	1.025	0.986
		Diesel	1.000	0.935

2.2.4 Off-Highway Recreational Vehicles

This source category includes offroad motorcycles, all terrain vehicles (ATV's), and offroad 4x4's. The emission inventory used for these vehicles was provided by CARB and used in the November 1994 SIP. It includes the effects of California phase 2 reformulated gasoline and control measures already adopted by California. The FIP does not provide any benefits beyond those.

2.2.5 Ships and Ports

The baseline inventories for large ocean-going vessels were taken directly from CARB and Ventura County inventories.

The specific benefit assumed for Ventura was 12.2 tons per day of NOx, based on Ventura County AQMP data indicating that this quantity of NOx comes from ship traffic going past Ventura which could be rerouted far enough off shore to negate the effects of the emissions in Ventura County. The remainder of the ship NOx is associated with ship traffic into and out of Ventura. For the South Coast, the control measures are expected to yield a 30% reduction in the ship NOx inventory.

2.2.6 Aircraft and Airports

All the FIP emissions inventories use CARB's aircraft inventory numbers and assume that the other two airport mobile source components (ground support equipment and ground access vehicles) are included in the overall FIP area inventories for nonroad equipment and on-highway vehicles, respectively.

Complete details of the calculation of benefits for the FIP airport related control measures are contained in a separate technical support document.

2.2.7 Military Bases

The only emission inventory data available for the military bases in the FIP areas were aircraft emission inventories. The inventory numbers used in the FIP were those provided by CARB with the November 1994 SIP. The FIP attainment demonstration assumes no benefits for these sources.

Mobile Source FIP Inventories and Benefits

South Coast Inventory
2010
(tons/day)

	VOC Baseline FIP	VOC Controls FIP	VOC Final FIP
Total Highway (a)	**174.08**	**66.85**	**107.23**
Nonroad			
Rec Vehs	2.66	0.00	2.66
Rec Boats	29.41	13.26	16.15
Comm. Boats (b)	1.39	0.00	1.39
Locomotives	1.73	0.00	1.73
Ships	1.23	0.00	1.23
Aircraft (c)	19.34	0.53	18.81
Mobile Equipt (d)	93.85	0.00	93.85
Lawn/Garden (e)	39.61	35.28	4.33
Total Nonroad	**189.22**	**49.07**	**140.16**
Total Mobile	**363.38**	**115.92**	**247.38**

(a) Controls include FIP I/M, 49-state import regs, and ILEVs.
(b) Includes both gas & diesel.
(c) Baseline is just aircraft. Benefits are just GSE and APU.
(d) Baseline with 6.9/5.8 Stds.
(e) FIP baseline includes only RFG, not state lawn/garden regs.

South Coast Inventory
2010
(tons/day)

	NOx Baseline FIP	NOx Controls FIP	NOx Final FIP
Total Highway (a)	**480.03**	**148.35**	**331.68**
Nonroad			
Rec Vehs	1.89	0.00	1.89
Rec Boats	4.40	2.02	2.38
Comm. Boats (b)	6.53	3.40	3.13
Locomotives	34.71	20.83	13.88
Ships	24.40	7.32	17.08
Aircraft (c)	18.42	3.87	14.55
Mobile Equipt (d)	253.73	46.43	207.30
Lawn/Garden (e)	1.59	-2.23	3.83
Total Nonroad	**345.67**	**81.64**	**264.04**
Total Mobile	**825.70**	**229.98**	**595.72**

(a) Includes FIP I/M + 49-state import regs.
(b) Includes both gas & diesel.
(c) Baseline is just aircraft. Benefits are just GSE and APU.
(d) Baseline with 6.9/5.8 Stds.
(e) FIP baseline includes only RFG, not state lawn/garden regs.

Ventura Inventory
2005
(tons/day)

	VOC Baseline FIP	VOC Controls FIP	VOC Final FIP
Total Highway (a)	**11.43**	**4.99**	**6.44**
Nonroad			
Rec Vehs	0.60	0.00	0.60
Rec Boats	0.34	0.05	0.29
Comm. Boats (b)	0.22	0.00	0.22
Locomotives	0.06	0.00	0.06
Ships	0.95	0.50	0.45
Aircraft (c)	0.56	0.00	0.56
Mobile Equipt (d)	1.55	0.00	1.55
Lawn/Garden (e)	1.64	0.91	0.73
Total Nonroad	**5.92**	**1.46**	**4.46**
Total Mobile	**17.35**	**6.45**	**10.90**

(a) Controls include FIP I/M, 49-state import regs, and ILEVs.
(b) Includes both gas & diesel.
(c) Baseline is just aircraft. Benefits are just GSE and APU.
(d) Baseline with 6.9/5.8 Stds.
(e) FIP baseline includes only RFG, not state lawn/garden regs.

Ventura Inventory
2005
(tons/day)

	NOx Baseline FIP	NOx Controls FIP	NOx Final FIP
Total Highway	**25.66**	**5.79**	**19.87**
Nonroad			
Rec Vehs	0.34	0.00	0.34
Rec Boats	0.37	0.02	0.35
Comm. Boats (b)	0.40	0.16	0.24
Locomotives	1.54	0.64	0.90
Ships	14.19	12.22	1.97
Aircraft (c)	0.85	0.00	0.85
Mobile Equipt (d)	5.71	0.34	5.37
Lawn/Garden (e)	0.08	-0.11	0.18
Total Nonroad	**23.47**	**13.28**	**10.20**
Total Mobile	**49.13**	**19.07**	**30.07**

(a) Includes FIP I/M + 49-state import regs.
(b) Includes both gas & diesel.
(c) Baseline is just aircraft. Benefits are just GSE and APU.
(d) Baseline with 6.9/5.8 Stds.
(e) FIP baseline includes only RFG, not state lawn/garden regs.

Sacramento Inventory
2005
(tons/day)

	VOC Baseline FIP	VOC Controls FIP	VOC Final FIP
Total Highway (a)	**38.12**	**16.93**	**21.19**
Nonroad			
Rec Vehs	1.11	0.00	1.11
Rec Boats	15.29	4.85	10.44
Comm. Boats (b)	0.14	0.00	0.14
Locomotives	0.39	0.00	0.39
Ships	0.00	0.00	0.00
Aircraft (c)	1.39	0.08	1.31
Mobile Equipt (d)	3.11	0.00	3.11
Lawn/Garden (e)	6.98	3.86	3.11
Total Nonroad	**28.40**	**8.79**	**19.61**
Total Mobile	**66.52**	**25.72**	**40.80**

(a) Controls include FIP I/M, 49-state import regs, and ILEVs.
(b) Includes both gas & diesel.
(c) Baseline is just aircraft. Benefits are just GSE and APU.
(d) Baseline with 6.9/5.8 Stds.
(e) FIP baseline includes only RFG, not state lawn/garden regs.

Sacramento Inventory
2005
(tons/day)

Sacramento Inventory (ton/day) NOx 2005	NOx Baseline FIP	NOx Controls FIP	NOx Final FIP
Total Highway (a)	**79.57**	**17.44**	**62.13**
Nonroad			
Rec Vehs	0.56	0.00	0.56
Rec Boats	2.31	1.66	0.65
Comm. Boats (b)	0.38	0.05	0.33
Locomotives	9.55	3.99	5.56
Ships	0.00	0.00	0.00
Aircraft (c)	1.97	0.22	1.75
Mobile Equipt (d)	14.42	0.88	13.54
Lawn/Garden (e)	0.21	-0.30	0.51
Total Nonroad	**29.40**	**6.50**	**22.90**
Total Mobile	**108.97**	**23.94**	**85.03**

(a) Includes FIP I/M + 49-state import regs.
(b) Includes both gas & diesel.
(c) Baseline is just aircraft. Benefits are just GSE and APU.
(d) Baseline with 6.9/5.8 Stds.
(e) FIP baseline includes only RFG, not state lawn/garden regs.